

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

LAND, Addick, Adrianus, Gosling
Arnold & Siedsma
Sweelinckplein 1
NL-2517 GK The Hague
PAYS-BAS

Date of mailing (day/month/year) 11 January 2001 (11.01.01)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference H AL/CDS/1	
International application No. PCT/NL99/00677	International filing date (day/month/year) 04 November 1999 (04.11.99)

1. The following indications appeared on record concerning:		
<input checked="" type="checkbox"/> the applicant	<input type="checkbox"/> the inventor	<input type="checkbox"/> the agent
<input type="checkbox"/> the common representative		
Name and Address CDS ENGINEERING B.V. Sonsbeekweg 26 NL-6814 BC Arnhem Netherlands	State of Nationality NL	State of Residence NL
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	
2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:		
<input checked="" type="checkbox"/> the person	<input type="checkbox"/> the name	<input type="checkbox"/> the address
<input type="checkbox"/> the nationality	<input type="checkbox"/> the residence	
Name and Address SPARK TECHNOLOGIES AND INNOVATIONS N.V. Kaya W.F.G. (Jombi) Mensing 36 Curaçao Netherlands Antilles	State of Nationality NL	State of Residence NL
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	
3. Further observations, if necessary:		
4. A copy of this notification has been sent to:		
<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned	
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned	
<input checked="" type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:	

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer R. Raissi
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

LAND, Addick, Adrianus, Gosling
Arnold & Siedsma
Sweelinckplein 1
NL-2517 GK The Hague
PAYS-BAS

Date of mailing (day/month/year) 03 April 2001 (03.04.01)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference H AL/CDS/1	
International application No. PCT/NL99/00677	International filing date (day/month/year) 04 November 1999 (04.11.99)

1. The following indications appeared on record concerning:		
<input checked="" type="checkbox"/> the applicant	<input type="checkbox"/> the inventor	<input type="checkbox"/> the agent <input type="checkbox"/> the common representative
Name and Address	State of Nationality	State of Residence
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	
2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:		
<input type="checkbox"/> the person	<input type="checkbox"/> the name	<input type="checkbox"/> the address <input type="checkbox"/> the nationality <input type="checkbox"/> the residence
Name and Address KOCH-GLITSCH N.V. Scharlooweg 81 Curaçao Netherlands Antilles	State of Nationality NL	State of Residence NL
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	
3. Further observations, if necessary: ADDITIONAL APPLICANT FOR ALL DESIGNATED STATES EXCEPT US.		
4. A copy of this notification has been sent to:		
<input checked="" type="checkbox"/> the receiving Office	<input type="checkbox"/> the designated Offices concerned	
<input type="checkbox"/> the International Searching Authority	<input checked="" type="checkbox"/> the elected Offices concerned	
<input type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:	

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Peggy Steunenbergh
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Assistant Commissioner for Patents
United States Patent and Trademark
Office
Box PCT
Washington, D.C.20231
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 26 July 2000 (26.07.00)	
International application No. PCT/NL99/00677	Applicant's or agent's file reference H AL/CDS/1
International filing date (day/month/year) 04 November 1999 (04.11.99)	Priority date (day/month/year) 04 November 1998 (04.11.98)
Applicant CUYPERS, Cindy, Thérèse, Cornelia et al	

1. The designated Office is hereby notified of its election made:



in the demand filed with the International Preliminary Examining Authority on:

05 June 2000 (05.06.00)



in a notice effecting later election filed with the International Bureau on:

2. The election ☒ was

was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

<p>The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland</p> <p>Facsimile No.: (41-22) 740.14.35</p>	<p>Authorized officer Pascal Piriou</p> <p>Telephone No.: (41-22) 338.83.38</p>
--	---

PCT JT COOPERATION TREATY

PCT

NOTIFICATION OF THE RECORDING
OF A CHANGE(PCT Rule 92bis.1 and
Administrative Instructions, Section 422)

From the INTERNATIONAL BUREAU

To:

LAND, Addick, Adrianus, Gosling
Arnold & Siedsma
Sweelinckplein 1
NL-2517 GK The Hague
BELGIQUE

Date of mailing (day/month/year) 04 April 2000 (04.04.00)	IMPORTANT NOTIFICATION
Applicant's or agent's file reference H AL/CDS/1	
International application No. PCT/NL99/00677	International filing date (day/month/year) 04 November 1999 (04.11.99)

1. The following indications appeared on record concerning:

☒ the applicant ☒ the inventor ☐ the agent ☐ the common representative

Name and Address	State of Nationality	State of Residence
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	

2. The International Bureau hereby notifies the applicant that the following change has been recorded concerning:

☒ the person ☒ the name ☒ the address ☐ the nationality ☐ the residence

Name and Address STANBRIDGE, David, Ian Rembrandtlaan 28 NL-6814 JM Arnhem Netherlands	State of Nationality NL	State of Residence NL
	Telephone No.	
	Facsimile No.	
	Teleprinter No.	

3. Further observations, if necessary:

New applicant and inventor for the purposes of the USA only.

4. A copy of this notification has been sent to:

<input checked="" type="checkbox"/> the receiving Office	<input checked="" type="checkbox"/> the designated Offices concerned
<input type="checkbox"/> the International Searching Authority	<input type="checkbox"/> the elected Offices concerned
<input type="checkbox"/> the International Preliminary Examining Authority	<input type="checkbox"/> other:

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Philippe Bécamel
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

REC'D 25 JAN 2001

WIPO

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference C PH/WH23/1	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416) FOR FURTHER ACTION	
International application No. PCT/NL99/00677	International filing date (day/month/year) 04/11/1999	Priority date (day/month/year) 04/11/1998
International Patent Classification (IPC) or national classification and IPC B04C3/00		
Applicant [CDS ENGINEERING B.V. ET AL] SPARK TECHNOLOGIES AND INNOVATIONS N.V.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.



2. This REPORT consists of a total of ⁴ sheets, including this cover sheet.

☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 2 sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 05/06/2000	Date of completion of this report 27.11.00
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0. Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Van Woensel, G Telephone No. +49 89 2399 2089 

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/NL99/00677

I. Basis of the report

1. This report has been drawn on the basis of (*substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments.*):

Description, pages:

1-6 as originally filed

Claims, No.:

1-12 as received on 04/10/2000 with letter of 02/10/2000

Drawings, sheets:

1-3 as originally filed

2. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

3. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

4. Additional observations, if necessary:

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. PCT/NL99/00677

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims 1-12
	No: Claims
Inventive step (IS)	Yes: Claims 1-12
	No: Claims
Industrial applicability (IA)	Yes: Claims 1-12
	No: Claims

2. Citations and explanations

see separate sheet

VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Ad V

1. Document WO 9749477, which is considered to represent the most relevant state of the art, discloses a device for treating a gas/liquid mixture according to the preamble of the present claim 1. The subject-matter of claim 1 differs from this document in that in document WO 9749477 anti-creep elements are extending some distance outward relative to the outlet opening of the return conduit instead of the divergence means of the present claim 1.

The problem to be solved by the present invention may therefore be regarded as how to prevent liquid creep along the outlet of the return conduit from entering the outlet flow without limiting the maximum output of the cyclone.

The solution to this problem proposed in claim 1 of the present application is considered as involving an inventive step (Article 33(3) PCT) since no prior art document teaches that divergence means be arranged close to the outer end of the return conduit for allowing the reintroduced flow to diverge laterally outward.

Independent claim 8 meets also the requirements of Article 33(3) PCT since it concerns an installation for separation water from gas, comprising one or more boxes in which the devices of claim 1 are arranged.

2. Claims 2-7, 10-12 and 9 are dependent on claim 1 or 8 and as such also meet the requirements of the PCT with respect to novelty and inventive step.
3. All claims of the present application are considered to be industrially applicable. Therefore, the present application meets all requirements of Article 33(2)-(4) PCT.

Ad VII

1. Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the document WO 97 49477 is not mentioned in the description, nor is this document identified therein.
2. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).

04. 10. 2000

(65)

1

CLAIMS

1. Device for treating a gas/liquid mixture, comprising:

- an inlet opening for the mixture;
- an outlet for the mixture located downstream;
- 5 - rotating means arranged in the tube for setting the mixture into rotating movement;
- one or more outlet openings arranged downstream relative to the rotating means for allowing a part of the mixture to flow laterally out of the tube;
- 10 - a return conduit arranged centrally in axial direction through the rotating means for reintroducing the flow which has exited via the outlet openings; characterised by
- divergence means arranged close to the outer
- 15 end of the return conduit for allowing the reintroduced flow to diverge laterally outward.

2. Device as claimed in claim 1, wherein the divergence means comprise slots (19) recessed into an end part (18) of the return conduit (16).

20 3. Device as claimed in claim 1 or 2, wherein the divergence means comprise a substantially conical element (17) close to the outer end of the return conduit.

25 4. Device as claimed in any of claims 1-3, wherein the outlet openings are formed by a number of longitudinal slots in the side wall of the tube.

5. Device as claimed in any of claims 1-4, wherein the rotating means comprise a swirl element, of which the outflow angle for the mixture amounts to 15°-
30 85°.

6. Device as claimed in claim 5, wherein the outflow angle amounts to about 45°, 60° or about 70°.

7. Device as claimed in any of the claims 1-6, wherein D_{s0} amounts to 4 μm or less.

Appl.No. PCT/NL99/00677 2
Encl.to letter dated 02.10.2000

8. Installation for separating water from gas,
comprising:

- a vessel provided with a connecting stub for
supply of the mixture;

5 - a drain conduit for draining liquid collected
in the bottom of the vessel; and

- one or more boxes in which one or more
devices as claimed in one or more of the claims 1-6 are
arranged.

10 9. Installation as claimed in claim 8, wherein
at least one liquid conduit extends between the box and
the space in the bottom of the vessel where the liquid is
collected.

10. Device for treating a gas/liquid mixture
15 according to any of the claims 1-7, comprising:

- an inlet opening for the mixture;

- rotating means arranged in the tube for
setting the mixture into rotating movement; and

20 - a substantially conically tapering outlet for
the mixture located downstream, wherein one or more slots
are arranged to allow a part of the mixture to flow
laterally out of the outlet.

11. Device as claimed in claim 10, wherein the
conicity amounts to 1°-30°.

25 12. Device as claimed in claim 10 or 11,
provided with an additional tube part which protrudes at
least partially upstream in the outlet.

AMENDED SHEET,

PCT

REQUEST

The undersigned requests that the present international application be processed according to the Patent Cooperation Treaty.

RECORD COPY

For receiving Office use only

PCT/NL

International Application

99 / 00677

04 NOV 1999

International Filing Date

(04.11.99)

BUREAU VOOR DE INDUSTRIËLE EIGENDOM
P.C.T. INTERNATIONAL APPLICATION

Name of receiving Office and "PCT International Application"

Applicant's or agent's file reference
(if desired) (12 characters maximum)

H AL/CDS/1

Box No. I TITLE OF INVENTION

DEVICE FOR TREATING A GAS/LIQUID MIXTURE

Box No. II APPLICANT

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

CDS Engineering B.V.
Sonsbeekweg 26
6814 BC ARNHEM
THE NETHERLANDS

☐ This person is also inventor.

Telephone No.

Facsimile No.

Teleprinter No.

State (that is, country) of nationality:

THE NETHERLANDS (NL)

State (that is, country) of residence:

THE NETHERLANDS (NL)

This person is applicant
for the purposes of:all designated
Statesall designated States except
the United States of Americathe United States
of America onlythe States indicated in
the Supplemental Box

Box No. III FURTHER APPLICANT(S) AND/OR (FURTHER) INVENTOR(S)

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country. The country of the address indicated in this Box is the applicant's State (that is, country) of residence if no State of residence is indicated below.)

CUYPERS, Cindy Thérèse Cornelia
Dakarhof 47
2622 CP DELFT
THE NETHERLANDS

This person is:

☐ applicant only☒ applicant and inventor☒ inventor only (If this check-box
is marked, do not fill in below.)

State (that is, country) of nationality:

THE NETHERLANDS (NL)

State (that is, country) of residence:

THE NETHERLANDS (NL)

This person is applicant
for the purposes of:all designated
Statesall designated States except
the United States of Americathe United States
of America onlythe States indicated in
the Supplemental Box☐ Further applicants and/or (further) inventors are indicated on a continuation sheet.

Box No. IV AGENT OR COMMON REPRESENTATIVE; OR ADDRESS FOR CORRESPONDENCE

The person identified below is hereby/has been appointed to act on behalf of the applicant(s) before the competent International Authorities as:



agent



common representative

Name and address: (Family name followed by given name; for a legal entity, full official designation. The address must include postal code and name of country.)

LAND, Addick Adrianus Gosling
ARNOLD & SIEDSMA
Sweelinckplein 1
2517 GK THE HAGUE
THE NETHERLANDS

Telephone No.

070-3654833 (dir.:030-2545352)

Facsimile No.

070-3452140
(direct: 030-2545372)

Teleprinter No.

☐ Address for correspondence: Mark this check-box where no agent or common representative is/has been appointed and the space above is used instead to indicate a special address to which correspondence should be sent.

Box No.V DESIGNATION OF STATES

The following designations are hereby made under Rule 4.9(a) (mark the applicable check-boxes; at least one must be marked):

Regional Patent

- ☒ AP ARIPO Patent: GH Ghana, GM Gambia, KE Kenya, LS Lesotho, MW Malawi, SD Sudan, SL Sierra Leone, SZ Swaziland, UG Uganda, ZW Zimbabwe, and any other State which is a Contracting State of the Harare Protocol and of the PCT
- ☒ EA Eurasian Patent: AM Armenia, AZ Azerbaijan, BY Belarus, KG Kyrgyzstan, KZ Kazakhstan, MD Republic of Moldova, RU Russian Federation, TJ Tajikistan, TM Turkmenistan, and any other State which is a Contracting State of the Eurasian Patent Convention and of the PCT
- ☒ EP European Patent: AT Austria, BE Belgium, CH and LI Switzerland and Liechtenstein, CY Cyprus, DE Germany, DK Denmark, ES Spain, FI Finland, FR France, GB United Kingdom, GR Greece, IE Ireland, IT Italy, LU Luxembourg, MC Monaco, NL Netherlands, PT Portugal, SE Sweden, and any other State which is a Contracting State of the European Patent Convention and of the PCT
- ☒ OA OAPI Patent: BF Burkina Faso, BJ Benin, CF Central African Republic, CG Congo, CI Côte d'Ivoire, CM Cameroon, GA Gabon, GN Guinea, GW Guinea-Bissau, ML Mali, MR Mauritania, NE Niger, SN Senegal, TD Chad, TG Togo, and any other State which is a member State of OAPI and a Contracting State of the PCT (if other kind of protection or treatment desired, specify on dotted line)

National Patent (if other kind of protection or treatment desired, specify on dotted line):

- | | |
|--|--|
| <input checked="" type="checkbox"/> AE United Arab Emirates | <input checked="" type="checkbox"/> LR Liberia |
| <input checked="" type="checkbox"/> AL Albania | <input checked="" type="checkbox"/> LS Lesotho |
| <input checked="" type="checkbox"/> AM Armenia | <input checked="" type="checkbox"/> LT Lithuania |
| <input checked="" type="checkbox"/> AT Austria | <input checked="" type="checkbox"/> LU Luxembourg |
| <input checked="" type="checkbox"/> AU Australia | <input checked="" type="checkbox"/> LV Latvia |
| <input checked="" type="checkbox"/> AZ Azerbaijan | <input checked="" type="checkbox"/> MD Republic of Moldova |
| <input checked="" type="checkbox"/> BA Bosnia and Herzegovina | <input checked="" type="checkbox"/> MG Madagascar |
| <input checked="" type="checkbox"/> BB Barbados | <input checked="" type="checkbox"/> MK The former Yugoslav Republic of Macedonia |
| <input checked="" type="checkbox"/> BG Bulgaria | |
| <input checked="" type="checkbox"/> BR Brazil | <input checked="" type="checkbox"/> MN Mongolia |
| <input checked="" type="checkbox"/> BY Belarus | <input checked="" type="checkbox"/> MW Malawi |
| <input checked="" type="checkbox"/> CA Canada | <input checked="" type="checkbox"/> MX Mexico |
| <input checked="" type="checkbox"/> CH and LI Switzerland and Liechtenstein | <input checked="" type="checkbox"/> NO Norway |
| <input checked="" type="checkbox"/> CN China | <input checked="" type="checkbox"/> NZ New Zealand |
| <input checked="" type="checkbox"/> CU Cuba | <input checked="" type="checkbox"/> PL Poland |
| <input checked="" type="checkbox"/> CZ Czech Republic | <input checked="" type="checkbox"/> PT Portugal |
| <input checked="" type="checkbox"/> DE Germany | <input checked="" type="checkbox"/> RO Romania |
| <input checked="" type="checkbox"/> DK Denmark | <input checked="" type="checkbox"/> RU Russian Federation |
| <input checked="" type="checkbox"/> EE Estonia | <input checked="" type="checkbox"/> SD Sudan |
| <input checked="" type="checkbox"/> ES Spain | <input checked="" type="checkbox"/> SE Sweden |
| <input checked="" type="checkbox"/> FI Finland | <input checked="" type="checkbox"/> SG Singapore |
| <input checked="" type="checkbox"/> GB United Kingdom | <input checked="" type="checkbox"/> SI Slovenia |
| <input checked="" type="checkbox"/> GD Grenada | <input checked="" type="checkbox"/> SK Slovakia |
| <input checked="" type="checkbox"/> GE Georgia | <input checked="" type="checkbox"/> SL Sierra Leone |
| <input checked="" type="checkbox"/> GH Ghana | <input checked="" type="checkbox"/> TJ Tajikistan |
| <input checked="" type="checkbox"/> GM Gambia | <input checked="" type="checkbox"/> TM Turkmenistan |
| <input checked="" type="checkbox"/> HR Croatia | <input checked="" type="checkbox"/> TR Turkey |
| <input checked="" type="checkbox"/> HU Hungary | <input checked="" type="checkbox"/> TT Trinidad and Tobago |
| <input checked="" type="checkbox"/> ID Indonesia | <input checked="" type="checkbox"/> UA Ukraine |
| <input checked="" type="checkbox"/> IL Israel | <input checked="" type="checkbox"/> UG Uganda |
| <input checked="" type="checkbox"/> IN India | <input checked="" type="checkbox"/> US United States of America |
| <input checked="" type="checkbox"/> IS Iceland | |
| <input checked="" type="checkbox"/> JP Japan | <input checked="" type="checkbox"/> UZ Uzbekistan |
| <input checked="" type="checkbox"/> KE Kenya | <input checked="" type="checkbox"/> VN Viet Nam |
| <input checked="" type="checkbox"/> KG Kyrgyzstan | <input checked="" type="checkbox"/> YU Yugoslavia |
| <input checked="" type="checkbox"/> KP Democratic People's Republic of Korea | <input checked="" type="checkbox"/> ZA South Africa |
| | <input checked="" type="checkbox"/> ZW Zimbabwe |
| <input checked="" type="checkbox"/> KR Republic of Korea | |
| <input checked="" type="checkbox"/> KZ Kazakhstan | |
| <input checked="" type="checkbox"/> LC Saint Lucia | |
| <input checked="" type="checkbox"/> LK Sri Lanka | |

Check-boxes reserved for designating States which have become party to the PCT after issuance of this sheet:

- ☐
☐

Precautionary Designation Statement: In addition to the designations made above, the applicant also makes under Rule 4.9(b) all other designations which would be permitted under the PCT except any designation(s) indicated in the Supplemental Box as being excluded from the scope of this statement. The applicant declares that those additional designations are subject to confirmation and that any designation which is not confirmed before the expiration of 15 months from the priority date is to be regarded as withdrawn by the applicant at the expiration of that time limit. (Confirmation of a designation consists of the filing of a notice specifying that designation and the payment of the designation and confirmation fees. Confirmation must reach the receiving Office within the 15-month time limit.)

PCT/NL

99/00677

Box No. VI PRIORITY CLAIM				
Filing date of earlier application (day/month/year)	Number of earlier application	Where earlier application is:		
		national application: country	regional application: regional Office	international application: receiving Office
item (1) 4 November 1998 (4/11/98)	1010478	The Netherlands		
item (2)				
item (3)				

☒ The receiving Office is requested to prepare and transmit to the International Bureau a certified copy of the earlier application(s) (only if the earlier application was filed with the Office which for the purposes of the present international application is the receiving Office) identified above as item(s): (1)

* Where the earlier application is an ARIPO application, it is mandatory to indicate in the Supplemental Box at least one country party to the Paris Convention for the Protection of Industrial Property for which that earlier application was filed (Rule 4.10(b)(ii)). See Supplemental Box.

Box No. VII INTERNATIONAL SEARCHING AUTHORITY

Choice of International Searching Authority (ISA) (if two or more International Searching Authorities are competent to carry out the international search, indicate the Authority chosen; the two-letter code may be used):

ISA /

Request to use results of earlier search; reference to that search (if an earlier search has been carried out by or requested from the International Searching Authority):

Date (day/month/year)

Number

Country (or regional Office)

23/03/1999

SN 31986

The Netherlands

Box No. VIII CHECK LIST; LANGUAGE OF FILING

This international application contains the following number of sheets:

request : 3

description (excluding sequence listing part) : 6

claims : 2

abstract : 1

drawings : 3

sequence listing part of description : _____

Total number of sheets : 15

This international application is accompanied by the item(s) marked below:

1. ☒ fee calculation sheet2. ☐ separate signed power of attorney3. ☐ copy of general power of attorney; reference number, if any:4. ☐ statement explaining lack of signature5. ☒ priority document(s) identified in Box No. VI as item(s): (1)6. ☐ translation of international application into (language):7. ☐ separate indications concerning deposited microorganism or other biological material8. ☐ nucleotide and/or amino acid sequence listing in computer readable form9. ☐ other (specify):

Figure of the drawings which should accompany the abstract:

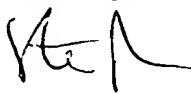
Language of filing of the international application:

Dutch

Box No. IX SIGNATURE OF APPLICANT OR AGENT

Next to each signature, indicate the name of the person signing and the capacity in which the person signs (if such capacity is not obvious from reading the request).

The Agent,


Duxbury, Stephen
for

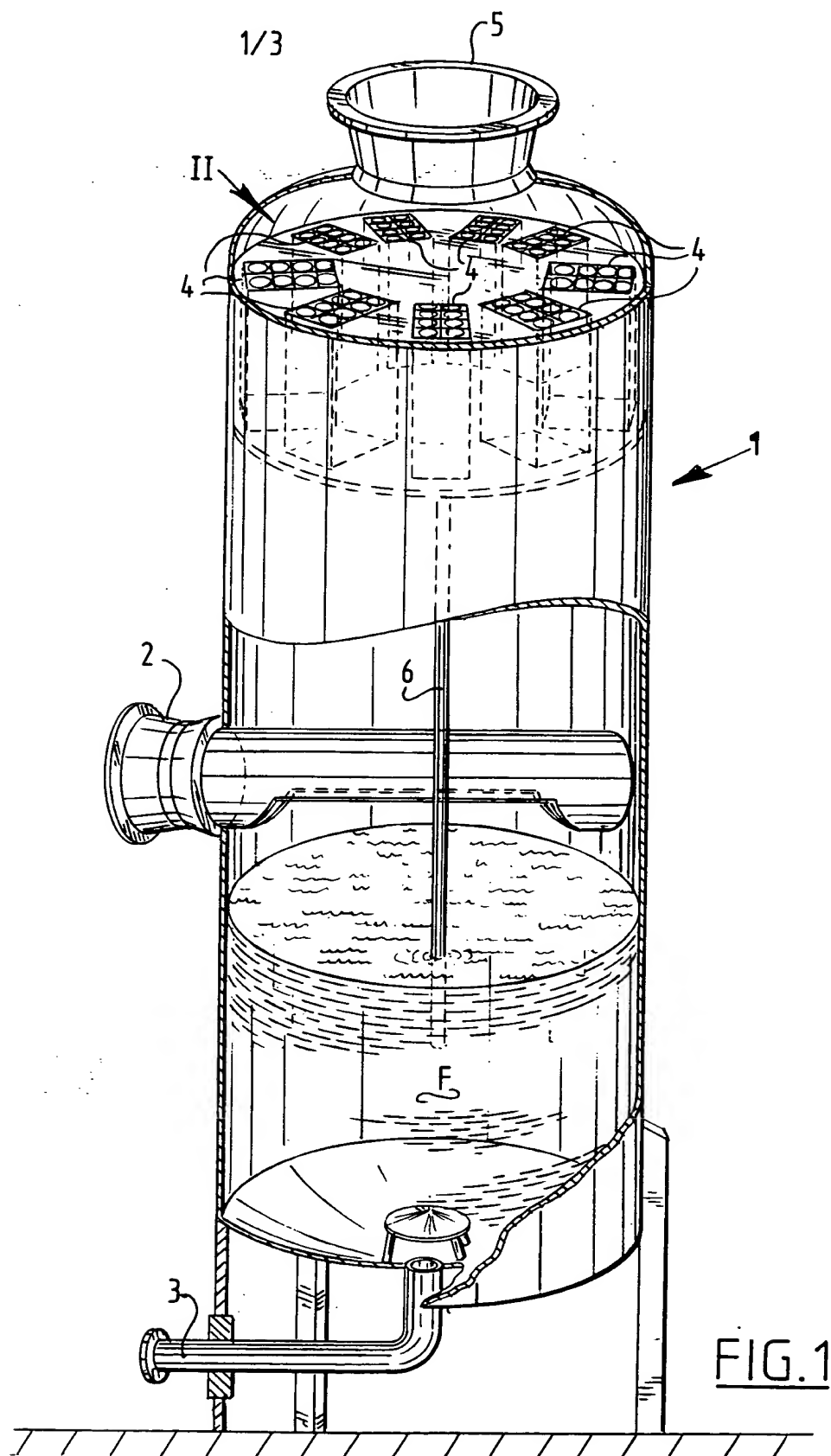
Land, Addick Adrianus Gosling

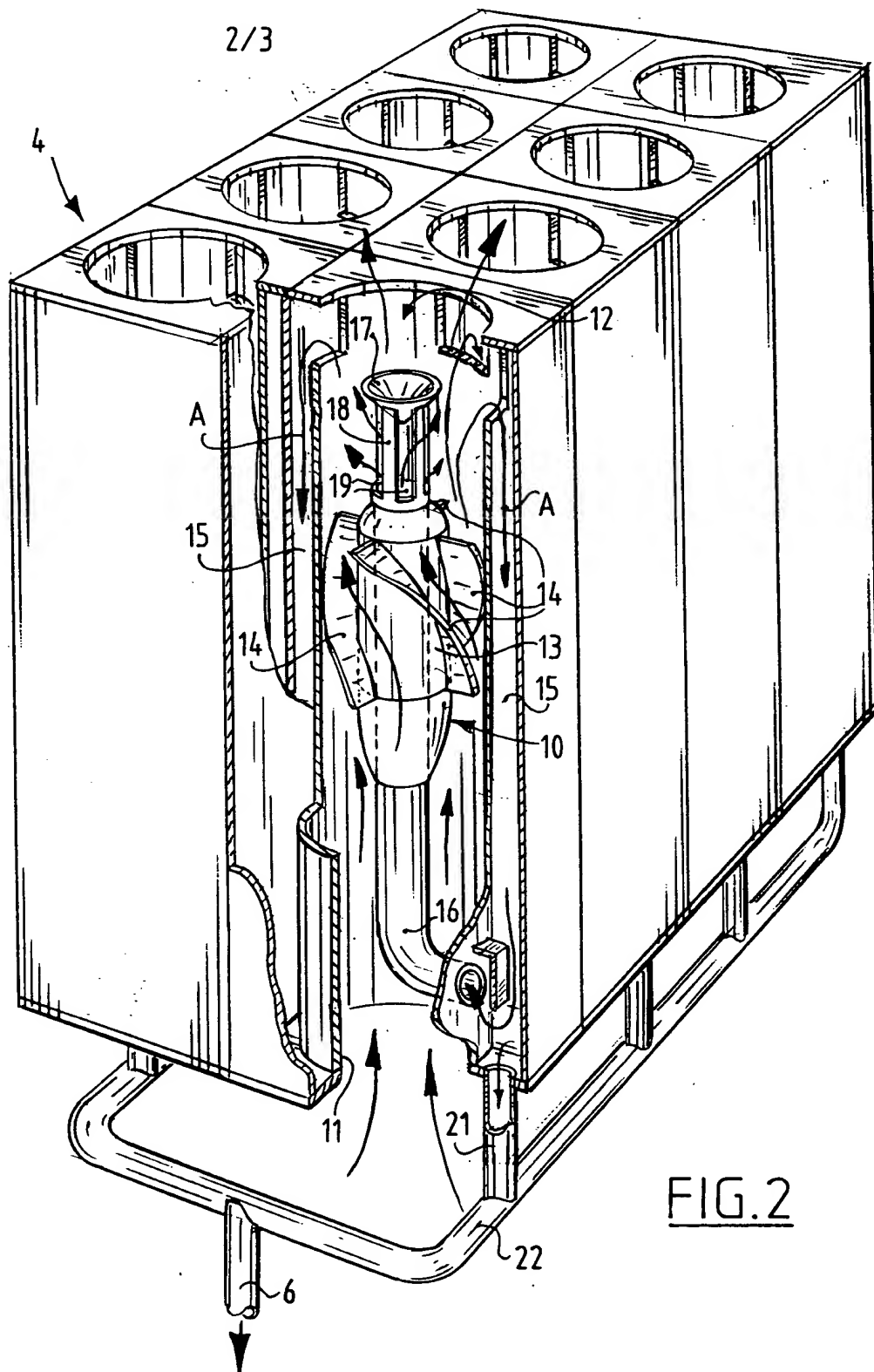
For receiving Office use only		2. Drawings: <input checked="" type="checkbox"/> received: <input type="checkbox"/> not received:
1. Date of actual receipt of the purported international application:	04 NOV 1999	
3. Corrected date of actual receipt due to later but timely received papers or drawings completing the purported international application:		
4. Date of timely receipt of the required corrections under PCT Article 11(2):		
5. International Searching Authority (if two or more are competent): ISA /	6. <input type="checkbox"/> Transmittal of search copy delayed until search fee is paid.	

Date of receipt of the record copy by the International Bureau:

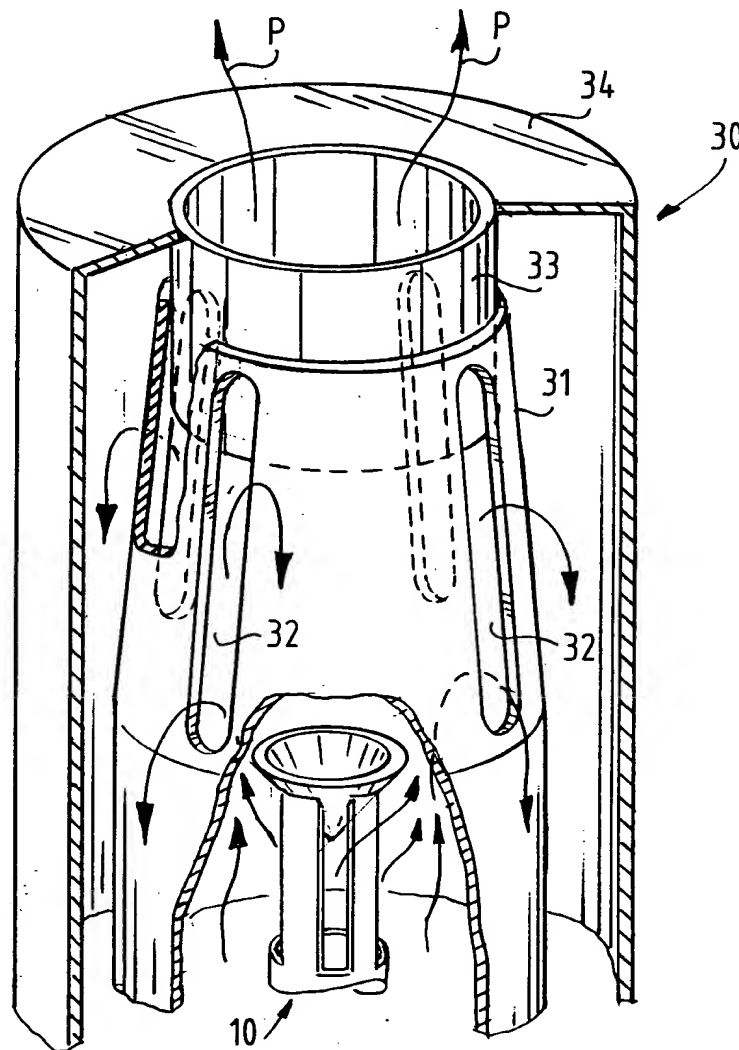
29 NOVEMBER 1999

(29. 11. 99)





3/3

FIG. 3

INRICHTING VOOR HET BEHANDELEN VAN EEN GAS/VLOEISTOFMENGSEL

Zogeheten cyclonen worden op grote schaal gebruikt voor het scheiden van gas/vloeistofmengsels, bijv. voor het drogen van aardgas. Bij winning kan het aardgas vermengd zijn met zout water, hetgeen veel corrosie kan veroorzaken in de pijpleidingen waardoorheen het gas moet stromen.

In een zogeheten axiale cycloon wordt het binnentredende mengsel in een draaiende beweging gebracht, waardoor een zware fractie (orde grootte 2 - 25% van de totale stroom) waarin zich relatief veel vloeistof bevindt, tegen de buitenwand van de cycloon wordt geslingerd. Door het aanbrengen van openingen in de buitenwand kan die fractie worden afgevoerd. Het is tevens reeds bekend een gedeelte van de afgevoerde fractie opnieuw in de vloeistofstroom in te brengen, teneinde ook die fractie verder in vloeistof- en gasfase te scheiden.

Bij de bekende cyclonen is de uitstroomopening voor de teruggevoerde stroom veelal in het hart van de cycloon aangebracht. Daar in het hart van de cycloon het mengsel een in hoofdzaak axiale snelheidscomponent heeft, kan langs de uitstroomopening kruip optreden, waardoor vloeistofdruppels uit de inlaatstroom in de uitlaatstroom treden. Bij het verhogen van de capaciteit, dat wil zeggen bij het verhogen van de druk en/of de hoeveelheid van het mengsel, treedt dergelijke kruip in verhevigde mate op.

Gezien het bovenstaande vormt de capaciteit van een dergelijke cycloon een beperking, waardoor installaties voor de gewenste gas/vloeistofscheiding in omvang zouden moeten toenemen, hetgeen ongewenst is.

De onderhavige uitvinding verschaft een inrichting voor het behandelen van een gas/vloeistofmengsel, omvattende:

- een met een inlaatopening voor het mengsel en
5 een stroomafwaarts gelegen uitlaat voor het mengsel;
- in de buis aangebracht draaimiddelen voor het in draaiende beweging brengen van het mengsel;
- een of meer stroomafwaarts ten opzichte van de draaimiddelen aangebrachte uitstroomopeningen voor het
10 zijdelings uit de buis laten stromen van een gedeelte van het mengsel;
- een in axiale richting door de draaimiddelen heen aangebrachte terugvoerleiding voor het opnieuw in de buis brengen van de via de uitstroomopeningen uitgetreden
15 stroom; en
- nabij de uitstroomopening van de terugvoerleiding aangebrachte divergentiemiddelen voor het zijwaarts laten divergeren van de opnieuw ingebrachte stroom.

20 Bij voorkeur omvatten de draaimiddelen een zogeheten swirl-element met een uitstroomhoek voor het mengsel van meer dan 30°, bijv. ongeveer 45°, 60° of 70°, waardoor de tangentiële snelheidscomponent van het mengsel, en derhalve het swirl-getal en het scheidingsrendement wordt verhoogd.
25

Verder verschaft de onderhavige uitvinding een installatie, waarbij één of meer inrichtingen volgens de onderhavige uitvinding worden toegepast.

Voorts verschaft de onderhavige uitvinding een
30 inrichting voor het behandelen van een gas/vloeistofmengsel, omvattende:

- een inlaatopening voor het mengsel;
- in de buis aangebracht draaimiddelen voor het in draaiende beweging brengen van het mengsel; en
35
- een stroomafwaarts gelegen in hoofdzaak conisch toelopende uitlaat voor het mengsel, waarbij één of meer sleuven zijn aangebracht voor het zijdelings uit de uitlaat laten stromen van een gedeelte van het mengsel.

Door de conisch toelopende uitlaatpijp blijft de druk aan de wand in hoofdzaak op een constante waarde, waardoor de scheiding van vloeistof via de sleuven beter verloopt, aangezien drukval wordt vermeden, waardoor
5 vloeistof in de uitlaatpijp opnieuw zou kunnen intreden.

Bij voorkeur is een additionele pijp stroomopwaarts in de uitlaatpijp, opdat de sleuven zo lang kunnen zijn als de uitlaatpijp toestaat.

Verdere voordelen, kenmerken en details van de
10 onderhavige uitvinding zullen worden verduidelijkt aan de hand van de navolgende beschrijving met verwijzing naar de bijgevoegde tekeningen, waarin tonen:

fig. 1 een gedeeltelijk schematisch aanzicht van een installatie voor scheiding van een gas/vloeistof-
15 mengsel, waarbij een inrichting volgens de onderhavige uitvinding wordt toegepast;

fig. 2 een gedeeltelijk opengewerkt aanzicht in perspectief van detail II uit fig. 1; en

fig. 3 een gedeeltelijk opengewerkt aanzicht in
20 perspectief van een verdere voorkeursuitvoeringsvorm van een inrichting volgens de onderhavige uitvinding.

Een vat 1 (fig. 1) is voorzien van een aansluitstomp 2 voor invoer van gas/vloeistofmengsels, zoals aardgas vermengd met (zout zee-)water. Onderin het vat 1
25 wordt de vloeistof F opgevangen, die via een leiding 3 kan worden afgevoerd. Naast een aantal niet getoonde scheidingsmiddelen zijn in het bovengedeelte van het vat 1 een aantal kasten (boxen) 4 aangebracht, terwijl daarboven een aansluitstomp 5 aan het vat is aangebracht voor
30 afvoer van althans gedeeltelijk of in aanzienlijke mate gedroogd gas. De kasten 4 zijn elk afzonderlijk of gemeenschappelijk van een leiding 6 voorzien die in verbinding staat met de vloeistof F onderin het vat, voor afvoer van vloeistof uit elk van de kasten.

35 Alhoewel in de onderhavige uitvoeringsvorm de kasten 4 in een verticale opstelling zijn getoond, kunnen deze in een andere, verder niet getoonde voorkeursuitvoeringsvorm, evenzeer liggend zijn opgesteld.

In een uitvoeringsvoorbeeld van een kast 4, fig. 2, bevinden zich acht cyclonen 10, waarvan er in fig. 2 een zichtbaar is, die elk omvatten een cilindrische wand 11, die aan de onderzijde een inlaat voor het gas/vloeistofmengsel vormen, en met een uitstroomopening 12 aan de bovenzijde daarvan. Ongeveer centraal in de door de cilindrische wand omsloten ruimte, is een zogeheten swirl-element 13 geplaatst, dat is voorzien van schoepen 14, voor het in draaiende beweging brengen van het mengsel. Door die draaiende beweging wordt een gedeelte van het mengsel, zoals aangeduid met pijlen A naar buiten geslingerd en via een tussenruimte 15 naar een recycle-leiding 16 gevoerd. Recycle-leiding 16 strekt zich uit door het swirl-element 13 heen en is aan de bovenzijde afgesloten met een in hoofdzaak kegelvormig hoedje 17. Onder het kegelvormige element 17 zijn sleuven 19 uitgespaard in een eindstuk 18 van de leiding 16 voor het divergerend laten uittreden van het via leidingen 16 gerecyclede mengsel (ca. 15% van de hoeveelheid van het oorspronkelijke mengsel). Op de ruimte 15 is voorts een leiding 21 aangesloten voor afvoer van vloeistof, die uitmondt op een ringleiding 22 waarop enerzijds afvoerleidingen van andere cyclonen uitmonden en anderzijds de afvoerleiding (downcomer) 6 naar de ruimte onderin het vat voor opvang van de vloeistof F.

Aan de bovenbeschreven cycloon zijn metingen gedaan onder atmosferische druk met een voor dit doel aangepaste buis van PITOT. Hiermede is het radiale drukprofiel in de buis, alsmede het zogeheten swirl-getal gemeten. Het swirl-getal, dat wil zeggen de verhouding van de tangentiële-impulsmomentflux ten opzichte van de axiale-impulsmomentflux van de stroming in de cycloon bepaalt voor een groot deel de scheidingskarakteristiek oftewel het rendement van de cycloon. In het algemeen is de waarde van de druk, die om de cycloon heerst, gelegen tussen de druk aan de wand en de druk ter plaatse waar de recyclebuis in de cycloon uitmondt. Door een steil drukprofiel tussen het hart en de wand van de cycloonbuis,

wordt verzekerd dat de recyclestroom krachtig genoeg is, en voorts dat de statische druk rondom de cycloon zo hoog mogelijk is.

5 Uit numerieke stromingssimulaties en bovengenoemd experimenteel onderzoek is gebleken; dat bovengenoemde doelen naast de toepassing van de boven beschreven divergerende stroom, wordt bereikt door de uitstroomhoek van het mengsel langs het swirl-element relatief groot te maken, bijv. ongeveer 45°, 60° of 70°, bij voorkeur in
10 ieder geval groter dan 30°, waardoor de tangentiële snelheidscomponent (en derhalve het swirl-getal en het scheidingsrendement) wordt verhoogd. Voor het behouden van een laminaire stroming langs een dergelijk swirl-element met hoge uitstroomhoek, is dit ontworpen met behulp van
15 numerieke stromingssimulatie-methoden.

Door de gerealiseerde zijwaartse uitstroom van de recyclestroming wordt vloeistofkruip naar het midden van het swirl-element (vrijwel) volledig voorkomen, daar er geen rechtuitgaande stroom meer aanwezig is in het
20 hart van de stroom. De van de recyclestroom afkomstige druppeltjes worden in de swirl-stroom meegesleurd en via de sleuven afgescheiden. Hierdoor wordt het tevens mogelijk de maximale capaciteit van de cycloon te verhogen. Uit de metingen onder atmosferische omstandigheden lijkt
25 de conclusie gewettigd dat capaciteit ook bij hogere druk en met een factor in de orde grootte van twee kan worden verhoogd.

Bij hogere capaciteit worden door de daarbij behorende hogere tangentiële snelheden kleine druppeltjes
30 beter afgescheiden. Dit wordt uitgedrukt als D_{50} , dat wil zeggen de gemiddelde diameter van 50% van de druppeltjes en bedraagt 4 μm bij de bovenbeschreven voorkeursuitvoeringsvorm van de onderhavige uitvinding.

Vrijwel de gehele gas/vloeistofstroming heeft
35 bij de inrichting volgens de onderhavige uitvinding een tangentiële snelheidscomponent, waardoor het swirl-getal hoger is en het scheidingsrendement evenzeer.

Doordat de gemiddelde druk in de kamer buiten de cycloon hoger wordt, wordt voorkomen dat vloeistof in de downcomer omhoog zou kunnen komen. Deze zogeheten Static Head neemt af met bijv. 3 - 12 mBar (onder atmosferische omstandigheden), waardoor de cycloon volgens de onderhavige uitvinding tevens beter bruikbaar is dan bestaande cyclonen in een horizontale opstelling.

Bij een inrichting 30 (fig. 3) is boven een swirl-element 10 een conisch toelopende uitstroompip 31 aangebracht, die is voorzien van uitstroomsleuven 32. Door de coniciteit van bijv. 1° - 30° , blijft de druk aan de rand van de wand op een constante waarde en wordt drukval in de uitlaatpijp vermeden. Aan de bovenzijde van de conische pijp 31 is een concentrische pijp 33 aangebracht, die enige mate stroomopwaarts in de pijp 31 steekt, en anderzijds aan een bovenwand 34 is bevestigd. Dit additionele pijpgedeelte 33 vormt een barrière voor de vloeistof aan het einde van de uitlaatpijp en minimaliseert derhalve de hoeveelheid vloeistof in de uitlaastroom, zoals die met pijlen P schematisch is aangegeven.

Voorts kunnen de uitstroomsleuven 32 zich over vrijwel de gehele lengte van de conische pijp 31 uitstrekken, tot voorbij de onderrand van het concentrische pijpgedeelte 33.

De onderhavige uitvinding is niet beperkt tot de boven beschreven voorkeursuitvoeringsvorm; de gevraagde rechten worden bepaald door de navolgende conclusies, binnen de strekking waarvan velerlei modificaties denkbaar zijn.

CONCLUSIES

1. Inrichting voor het behandelen van een gas/vloeistofmengsel, omvattende:

- een inlaatopening voor het mengsel;
- een stroomafwaarts gelegen uitlaat voor het
5 mengsel;
- in de buis aangebracht draaimiddelen voor het in draaiende beweging brengen van het mengsel;
- een of meer stroomafwaarts ten opzichte van de draaimiddelen aangebrachte uitstroomopeningen voor het
10 zijdelings uit de buis laten stromen van een gedeelte van het mengsel;
- een in axiale richting door de draaimiddelen heen aangebrachte terugvoerleiding voor het opnieuw in de buis brengen van de via de uitstroomopeningen uitgetreden
15 stroom; en
- nabij de uitstroomopening van de terugvoerleiding aangebrachte divergentiemiddelen voor het zijwaarts laten divergeren van de opnieuw ingebrachte stroom.

20 2. Inrichting volgens conclusie 1, waarbij de uitstroomopeningen worden gevormd door een aantal langs-sleuven in de zijwand van de buis.

3. Inrichting volgens conclusie 1 of 2, waarbij de draaimiddelen een swirl-element omvatten, waarvan de
25 uitstroomhoek voor het mengsel meer dan 15° - 85° bedraagt.

4. Inrichting volgens conclusie 3, waarbij de uitstroomhoek ongeveer 45°, 60° of ongeveer 70° bedraagt.

5. Inrichting volgens één van de conclusies 1 -
30 4, waarbij D_{50} 4 μ m of minder bedraagt.

6. Inrichting volgens één of meer van de conclusies 1 - 5, waarbij de divergentiemiddelen een in

hoofdzaak kegelvormig element nabij het uiteinde van de terugvoerleiding omvatten.

7. Installatie voor het afscheiden van water uit gas, omvattende:

- 5 - een vat voorzien van een aansluitstomp voor aanvoer van het mengsel;
- een afvoerleiding voor afvoer van onder in het vat verzamelde vloeistof; en
- één of meer kasten waarin één of meer inrich-
- 10 tingen volgens één of meer van de conclusies 1 - 6 zijn aangebracht.

8. Installatie volgens conclusie 7, waarbij ten minste één vloeistofleiding zich uitstrekt tussen de kast en de ruimte onderin het vat waar de vloeistof wordt

15 verzameld.

9. Inrichting voor het behandelen van een gas/vloeistofmengsel, omvattende:

- een inlaatopening voor het mengsel;
- in de buis aangebracht draaimiddelen voor het
- 20 in draaiende beweging brengen van het mengsel; en
- een stroomafwaarts gelegen in hoofdzaak conisch toelopende uitlaat voor het mengsel, waarbij één of meer sleuven zijn aangebracht voor het zijdelings uit de uitlaat laten stromen van een gedeelte van het meng-
- 25 sel.

10. Inrichting volgens conclusie 9, waarbij de coniciteit 1° - 30° bedraagt.

11. Inrichting volgens conclusie 9 of 10, voorzien van een additioneel pijpgedeelte dat ten minste

30 gedeeltelijk stroomopwaarts in de uitlaat steekt.

UITTREKSEL

De onderhavige uitvinding betreft een inrichting voor het behandelen van een gas/vloeistofmengsel, omvattende:

- een inlaatopening voor het mengsel;
- 5 - een stroomafwaarts gelegen uitlaat voor het mengsel;
- - in de buis aangebracht draaimiddelen voor het in draaiende beweging brengen van het mengsel;
- - een of meer stroomafwaarts ten opzichte van
10 de draaimiddelen aangebrachte uitstroomopeningen voor het zijdelings uit de buis laten stromen van een gedeelte van het mengsel;
- - een in axiale richting door de draaimiddelen heen aangebrachte terugvoerleiding voor het opnieuw in de
15 buis brengen van de via de uitstroomopeningen uitgetreden stroom; en
- - nabij de uitstroomopening van de terugvoerleiding aangebrachte divergentiemiddelen voor het zijwaarts laten divergeren van de opnieuw ingebrachte
20 stroom.



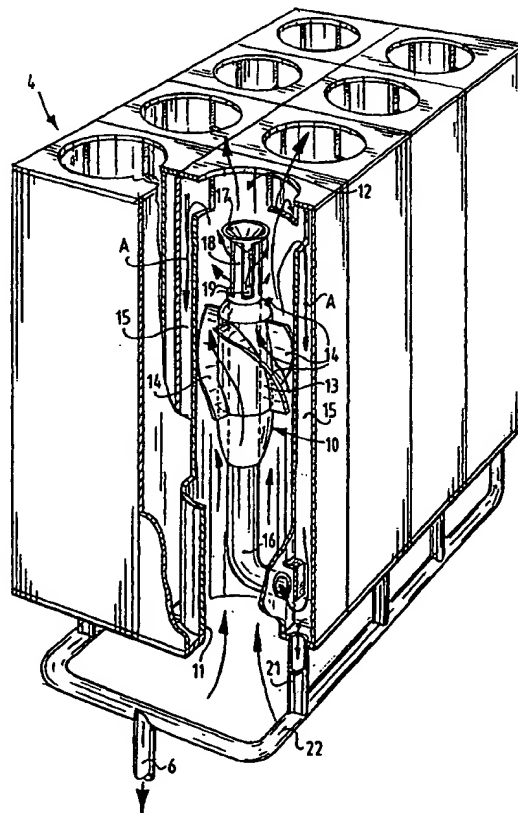
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁷ : B04C 3/00, 3/04		A1	(11) International Publication Number: WO 00/25931
			(43) International Publication Date: 11 May 2000 (11.05.00)
(21) International Application Number: PCT/NL99/00677 (22) International Filing Date: 4 November 1999 (04.11.99) (30) Priority Data: 1010478 4 November 1998 (04.11.98) NL (71) Applicant (for all designated States except US): CDS ENGINEERING B.V. [NL/NL]; Sonsbeekweg 26, NL-6814 BC Arnhem (NL). (72) Inventors; and (75) Inventors/Applicants (for US only): CUYPERS, Cindy, Thérèse, Cornelia [NL/NL]; Dakarhof 47, NL-2622 CP Delft (NL). STANBRIDGE, David, Ian [NL/NL]; Rembrandtlaan 28, NL-6814 JM Arnhem (NL). (74) Agent: LAND, Addick, Adrianus, Gosling; Arnold & Siedsma, Sweelinckplein 1, NL-2517 GK The Hague (NL).		(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG). Published <i>With international search report.</i> <i>In English translation (filed in Dutch).</i>	

(54) Title: DEVICE FOR TREATING A GAS/LIQUID MIXTURE

(57) Abstract

The present invention relates to a device for treating a gas/liquid mixture, comprising: an inlet opening for the mixture; an outlet (12) for the mixture located downstream; rotating means (13) arranged in the tube for setting the mixture into rotating movement; one or more outlet openings arranged downstream relative to the rotating means (13) for allowing a part of the mixture to flow laterally out of the tube; a return conduit (16) arranged in axial direction through the rotating means (13) for reintroducing into the tube the flow which has exited via the outlet openings; and divergence means (17) arranged close to the outlet opening of the return conduit (16) for allowing the reintroduced flow to diverge laterally.



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DEVICE FOR TREATING A GAS/LIQUID MIXTURE

So-called cyclones are used on a large scale to separate gas/liquid mixtures, for instance to dry natural gas. On extraction the natural gas can be mixed with salt water, which can cause much corrosion in the pipelines
5 through which the gas must flow.

In a so-called axial cyclone the entering mixture is set into a rotating movement, whereby a heavy fraction (in the order of magnitude of 2-25% of the total flow) in which a relatively large amount of liquid is
10 present, is flung against the outer wall of the cyclone. This fraction can be discharged by arranging openings in the outer wall. It is also already known to reintroduce a part of the discharged fraction into the liquid flow in order to further separate this fraction as well into
15 liquid and gas phase.

In the known cyclones the outlet opening for the returned flow is usually arranged in the centre of the cyclone. As the mixture has a substantially axial speed component in the centre of the cyclone, creep may
20 occur along the outlet opening whereby liquid droplets from the inlet flow enter the outlet flow. When capacity is increased, i.e. when the pressure and/or the quantity of the mixture is increased, such creep will become worse.

25 In view of the above, the capacity of such a cyclone forms a limitation, whereby installations for the desired gas/liquid separation would have to increase in size, which is undesirable.

The present invention provides a device for
30 treating a gas/liquid mixture, comprising:

- an inlet opening for the mixture and an outlet for the mixture located downstream;

- rotating means arranged in the tube for setting the mixture into rotating movement;

- one or more outlet openings arranged downstream relative to the rotating means for allowing a part of the mixture to flow laterally out of the tube;

- a return conduit arranged in axial direction through the rotating means for reintroducing into the tube the flow which has exited via the outlet openings; and

- divergence means arranged close to the outlet opening of the return conduit for allowing the reintroduced flow to diverge laterally.

The rotating means preferably comprise a so-called swirl element with an outflow angle for the mixture of more than 30° , for instance roughly 45° , 60° or 70° , whereby the tangential speed component of the mixture, and therefore the swirl number, and the separation efficiency are increased.

The present invention further provides an installation, wherein one or more devices according to the present invention are applied.

The present invention further provides a device for treating a gas/liquid mixture, comprising:

- an inlet opening for the mixture;

- rotating means arranged in the tube for setting the mixture into rotating movement; and

- a substantially conically tapering outlet for the mixture located downstream, wherein one or more slots are arranged to allow a part of the mixture to flow laterally out of the outlet.

Due to the conically tapering outlet pipe the pressure on the wall remains substantially at a constant value, whereby the separation of liquid via the slots proceeds better since pressure drop, whereby liquid could re-enter the outlet pipe, is avoided.

An additional tube is preferably arranged upstream in the outlet pipe, so that the slots can be as long as the outlet pipe permits.

Further advantages, features and details of the present invention will be elucidated on the basis of the following description with reference to the annexed drawings, in which:

5 fig. 1 shows a partly schematic view of an installation for separating a gas/liquid mixture, wherein a device according to the present invention is applied;

 fig. 2 shows a partly cut-away view in perspective of detail II of fig. 1; and

10 fig. 3 shows a partly cut-away view in perspective of a further preferred embodiment of a device according to the present invention.

 A vessel 1 (fig. 1) is provided with a connecting stub 2 for intake of gas/liquid mixtures, such as natural gas mixed with (salt sea)water. At the bottom of vessel 1 is collected the liquid F which can be drained via a pipe 3. In addition to a number of separating means (not shown), a number of boxes 4 are arranged in the upper part of vessel 1, while thereabove a connecting stub 5 is arranged on the vessel for discharging gas which has been dried at least partially or to a considerable degree. Boxes 4 are each provided individually or collectively with a conduit 6 which is in communication with the liquid F in the bottom of the vessel for draining liquid from each of the boxes.

 Although in the present embodiment the boxes 4 are shown in a vertical arrangement, they can also be in a lying arrangement in another preferred embodiment which is not further shown.

30 In an embodiment of a box 4, fig. 2, are situated eight cyclones 10, one of which is shown in fig. 2, which each comprise a cylindrical wall 11 which forms on the underside an inlet for the gas/liquid mixture, and an outlet opening 12 on the upper side thereof. Roughly centrally in the space enclosed by the cylindrical wall is placed a so-called swirl element 13 which is provided with blades 14 for setting the mixture into rotating movement. A part of the mixture is flung outward by this

rotating movement, as indicated with arrows A, and transported via an interspace 15 to a recycle conduit 16. Recycle conduit 16 extends through swirl element 13 and is closed at the top with a substantially conical cap 17.

5 Under conical element 17 slots 19 are recessed into an end part 18 of conduit 16 to allow the mixture recycled via conduits 16 (about 15% of the quantity of the original mixture) to exit in divergent manner. Further connected to space 15 is a conduit 21 for draining

10 liquid, which conduit debouches onto a ring line 22 into which drain conduits of other cyclones debouch on one side and the downcomer 6 to the space in the bottom of the vessel for collecting liquid F is connected on the other.

15 Measurements have been taken on the above described cyclone under atmospheric pressure with a PITOT tube adapted for this purpose. The radial pressure profile in the tube is measured herewith as well as the so-called swirl number. The swirl number, i.e. the ratio

20 of the tangential angular momentum flux relative to the axial angular momentum flux of the flow in the cyclone largely determines the separation characteristic or the efficiency of the cyclone. The value of the pressure prevailing around the cyclone generally lies between the

25 pressure on the wall and the pressure at the location where the recycle conduit debouches into the cyclone. A steep pressure profile between the centre and the wall of the cyclone tube ensures that the recycle flow is sufficiently powerful, and furthermore that the static

30 pressure around the cyclone is as high as possible.

 It has been found from numerical flow simulations and the above mentioned experimental research that the above stated objectives are achieved not only by using the above described diverging flow but also by

35 making the outflow angle of the mixture along the swirl element relatively large, for instance about 45°, 60° or 70°, preferably in any case greater than 30°, whereby the tangential speed component (and therefore the swirl

number and the separation efficiency) is increased. In order to sustain a laminar flow along such a swirl element with large outflow angle, this latter is designed using numerical flow simulation methods.

5 Due to the realized lateral outflow of the recycle flow, liquid creep to the middle of the swirl element is (all but) wholly prevented, as straight moving flow is no longer present in the centre of the flow. The droplets coming from the recycle flow are entrained in
10 the swirl flow and separated via the slots. It also becomes possible hereby to increase the maximum capacity of the cyclone. From the measurements under atmospheric conditions the conclusion seems justified that capacity can also be increased at higher pressure and with a
15 factor in the order of magnitude of two.

 At higher capacity small droplets are separated better by the associated higher tangential speeds. This is expressed as D_{50} , i.e. the average diameter of 50% of the droplets, and amounts to 4 μm in the above described
20 preferred embodiment of the present invention.

 In the device according to the present invention practically the whole gas/liquid flow has a tangential speed component, whereby the swirl number is higher as well as the separation efficiency.

25 Because the average pressure in the chamber outside the cyclone becomes higher, liquid in the downcomer is prevented from being able to move upward. This so-called Static Head decreases with for instance 3-12 mBar (under atmospheric conditions), whereby the
30 cyclone according to the present invention is also more useful than existing cyclones in a horizontal arrangement.

 Arranged above a swirl element 10 in a device
30 (fig. 3) is a conically tapering outlet pipe 31 which
35 is provided with outflow slots 32. Due to the conicity of for instance 1° - 30° the pressure at the edge of the wall remains at a constant value and pressure drop in the outlet pipe is avoided. On the top part of conical pipe

31 is arranged a concentric pipe 33 which protrudes upstream to some extent into pipe 31 and is fixed on the other side to an upper wall 34. This additional pipe part 33 forms a barrier for the liquid at the end of the outlet pipe and therefore minimizes the quantity of liquid in the outlet flow, as indicated schematically with arrows P.

Outflow slots 32 can further extend over practically the whole length of conical pipe 31, beyond the bottom edge of concentric pipe part 33.

The present invention is not limited to the above described preferred embodiment; the rights sought are defined by the following claims, within the scope of which many modifications can be envisaged.

CLAIMS

1. Device for treating a gas/liquid mixture, comprising:

- an inlet opening for the mixture;
- an outlet for the mixture located downstream;
- 5 - rotating means arranged in the tube for setting the mixture into rotating movement;
- one or more outlet openings arranged downstream relative to the rotating means for allowing a part of the mixture to flow laterally out of the tube;
- 10 - a return conduit arranged in axial direction through the rotating means for reintroducing into the tube the flow which has exited via the outlet openings; and
- divergence means arranged close to the outlet
- 15 opening of the return conduit for allowing the reintroduced flow to diverge laterally.

2. Device as claimed in claim 1, wherein the outlet openings are formed by a number of longitudinal slots in the side wall of the tube.

20 3. Device as claimed in claim 1 or 2, wherein the rotating means comprise a swirl element, of which the outflow angle for the mixture amounts to 15°-85°.

 4. Device as claimed in claim 3, wherein the outflow angle amounts to about 45°, 60° or about 70°.

25 5. Device as claimed in any of the claims 1-4, wherein D_{50} amounts to 4 μm or less.

 6. Device as claimed in one or more of the claims 1-5, wherein the divergence means comprise a substantially conical element close to the outer end of

30 the return conduit.

 7. Installation for separating water from gas, comprising:

- a vessel provided with a connecting stub for supply of the mixture;

- a drain conduit for draining liquid collected in the bottom of the vessel; and

5 - one or more boxes in which one or more devices as claimed in one or more of the claims 1-6 are arranged.

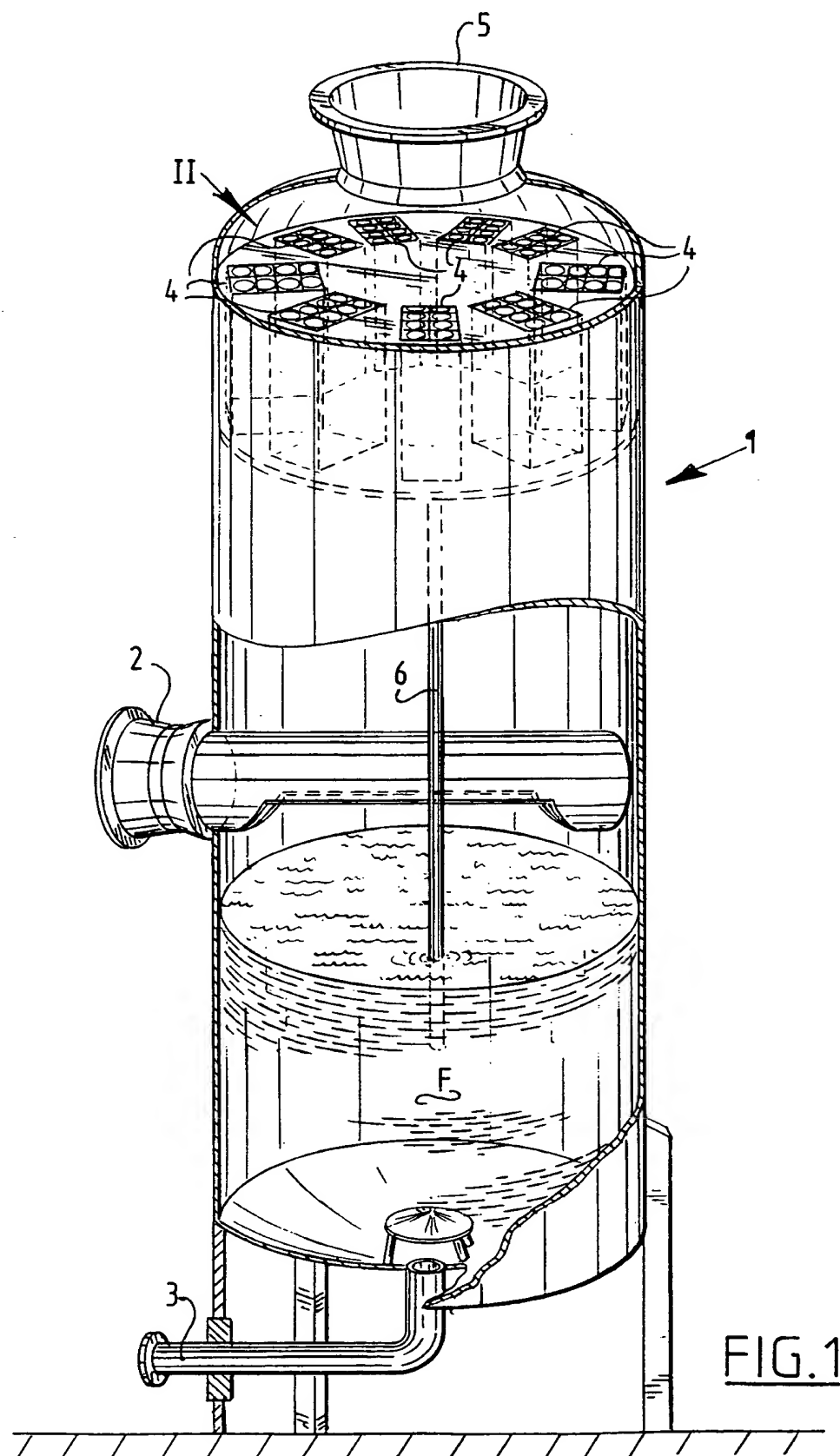
8. Installation as claimed in claim 7, wherein at least one liquid conduit extends between the box and
10 the space in the bottom of the vessel where the liquid is collected.

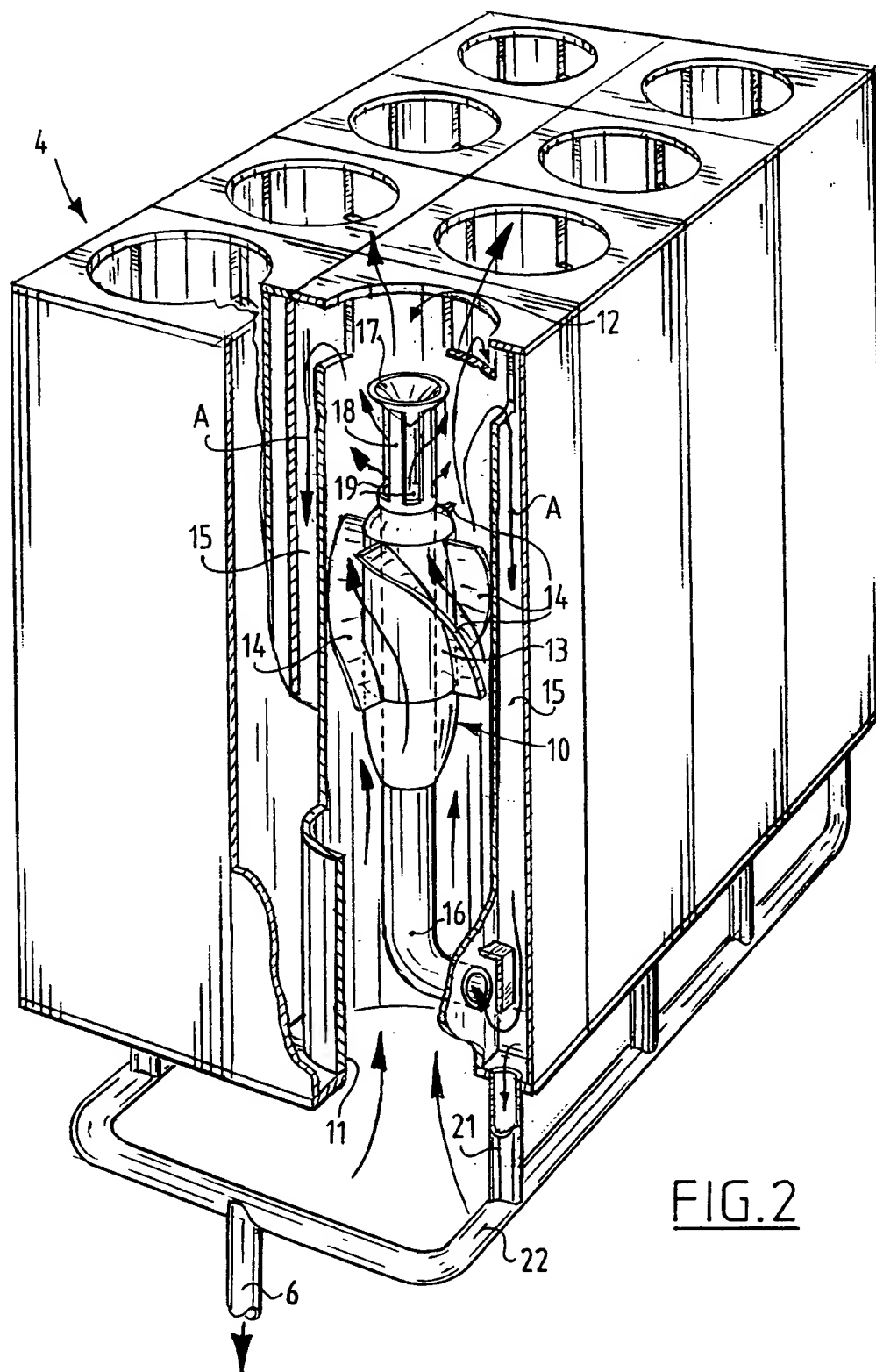
9. Device for treating a gas/liquid mixture, comprising:

15 - an inlet opening for the mixture;
 - rotating means arranged in the tube for setting the mixture into rotating movement; and
 - a substantially conically tapering outlet for the mixture located downstream, wherein one or more slots are arranged to allow a part of the mixture to flow
20 laterally out of the outlet.

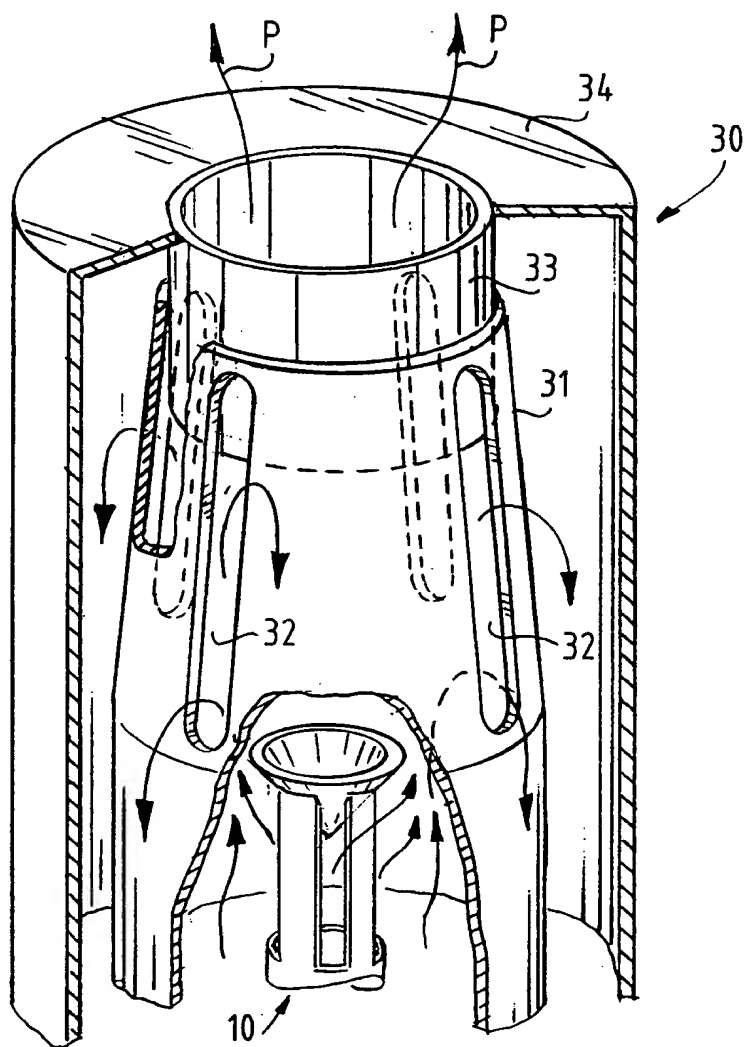
10. Device as claimed in claim 9, wherein the conicity amounts to 1°-30°.

11. Device as claimed in claim 9 or 10, provided with an additional tube part which protrudes at
25 least partially upstream in the outlet.





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FIG. 3

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/NL 99/00677

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B04C3/00 B04C3/04

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B04C B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
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- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

- "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
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Date of the actual completion of the international search

27 January 2000

Date of mailing of the international search report

04/02/2000

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INTERNATIONAL SEARCH REPORT

Inte Application No
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